ENGLISH

PowerSeeker® Series Telescopes

INSTRUCTION MANUAL

- ***PowerSeeker 60EQ # 21043***
- ***PowerSeeker 70EQ # 21037***
- ***PowerSeeker 80EQ # 21048***
- ***PowerSeeker 114EQ # 21045***
- ***PowerSeeker 127EQ # 21049***

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CELESTRON Introduction

Congratulations on your purchase of a PowerSeeker telescope. The PowerSeeker Series of telescopes come in several different models and this manual covers five models mounted on a German Equatorial Mount --- 60mm refractor, 70mm refractor, 80mm refractor, 114mm Newtonian, and 127mm Newtonian. The PowerSeeker Series is made of the highest quality materials to ensure stability and durability. All this adds up to a telescope that gives you a lifetime of pleasure with a minimal amount of maintenance.

These telescopes were designed for the First Time Buyer offering exceptional value. The PowerSeeker series features a compact and portable design with ample optical performance to excite any newcomer to the world of amateur astronomy.

PowerSeeker telescopes carry a **two year limited warranty**. For details see our website at www.celestron.com

Some of the many standard features of the PowerSeeker include:

- All coated glass optical elements for clear, crisp images.
- Smooth functioning, rigid equatorial mount with setting circles in both axes.
- Preassembled aluminum tripod ensures a stable platform.
- Quick and easy no-tool set up.
- CD-ROM "The Sky" Level 1 -- astronomy software which provides education about the sky and printable sky maps.
- All models can be used terrestrially as well as astronomically with the standard accessories included.

Take time to read through this manual before embarking on your journey through the Universe. It may take a few observing sessions to become familiar with your telescope, so you should keep this manual handy until you have fully mastered your telescope's operation. The manual gives detailed information regarding each step as well as needed reference material and helpful hint to make your observing experience as simple and pleasurable as possible.

Your telescope is designed to give you years of fun and rewarding observations. However, there are a few things to consider before using your telescope that will ensure your safety and protect your equipment.

Warning

- **Never look directly at the sun with the naked eye or with a telescope (unless you have the proper solar filter). Permanent and irreversible eye damage may result.**
- **Never use your telescope to project an image of the sun onto any surface. Internal heat build-up can damage the telescope and any accessories attached to it.**
- **Never use an eyepiece solar filter or a Herschel wedge. Internal heat build-up inside the telescope can cause these devices to crack or break, allowing unfiltered sunlight to pass through to the eye.**
- **Do not leave the telescope unsupervised, either when children are present or adults who may not be familiar with the correct operating procedures of your telescope.**

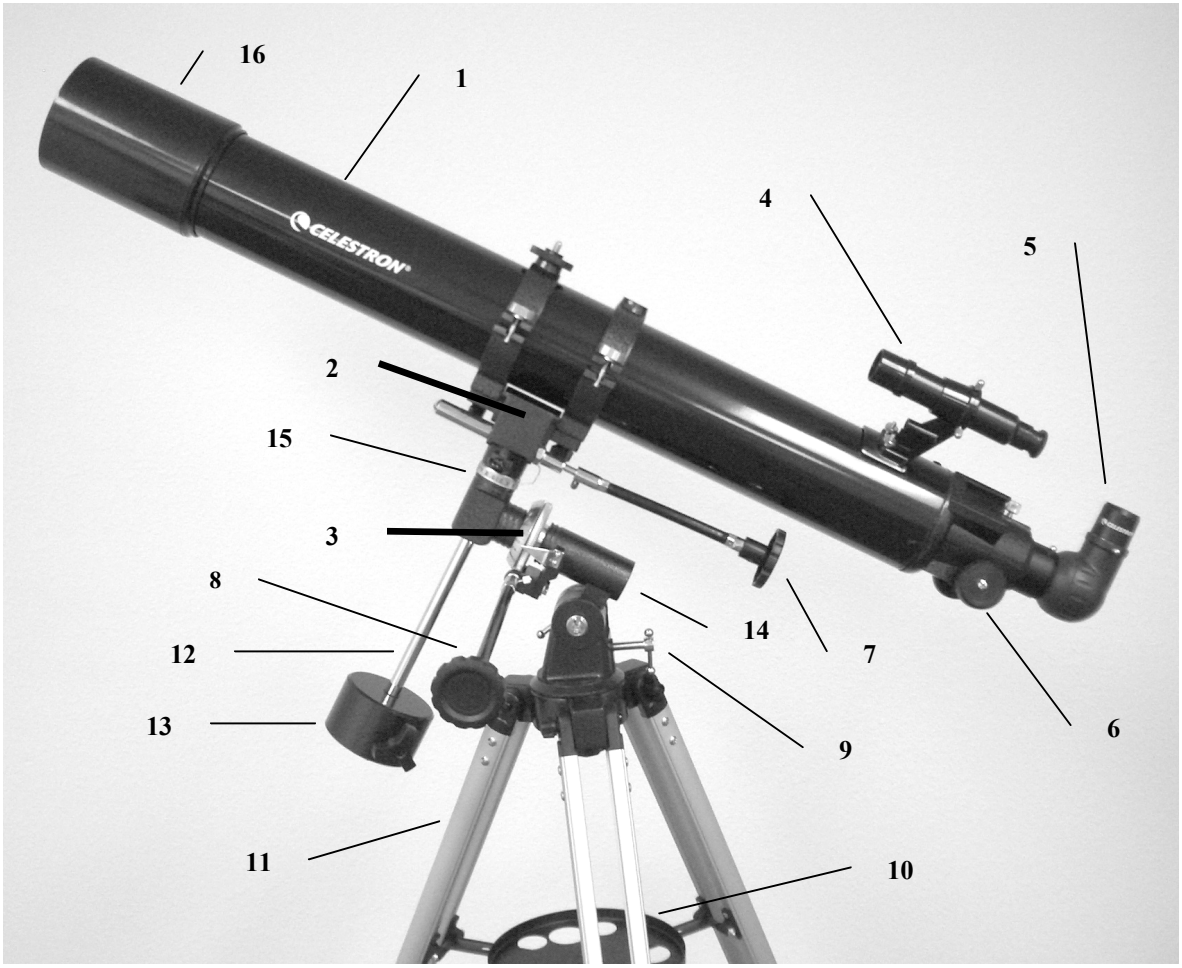


Figure 1-1 PowerSeeker 80EQ Refractor
PowerSeeker 60EQ & PowerSeeker 70EQ Similar

1.	**Telescope Optical Tube**	**9.**	**Latitude Adjustment Screw**
2.	**Mounting Bracket w/ Tube Rings**	**10.**	**Tripod Accessory Tray**
3.	**R.A. Setting Circle**	**11.**	**Tripod**
4.	**Finderscope**	**12.**	**Counterweight Bar**
5.	**Eyepiece & Diagonal**	**13.**	**Counterweight**
6.	**Focus Knob**	**14.**	**Equatorial Mount**
7.	**Dec. Slow Motion Cable**	**15.**	**Dec. Setting Circle**
8.	**R.A. Slow Motion Cable**	**16.**	**Objective Lens**

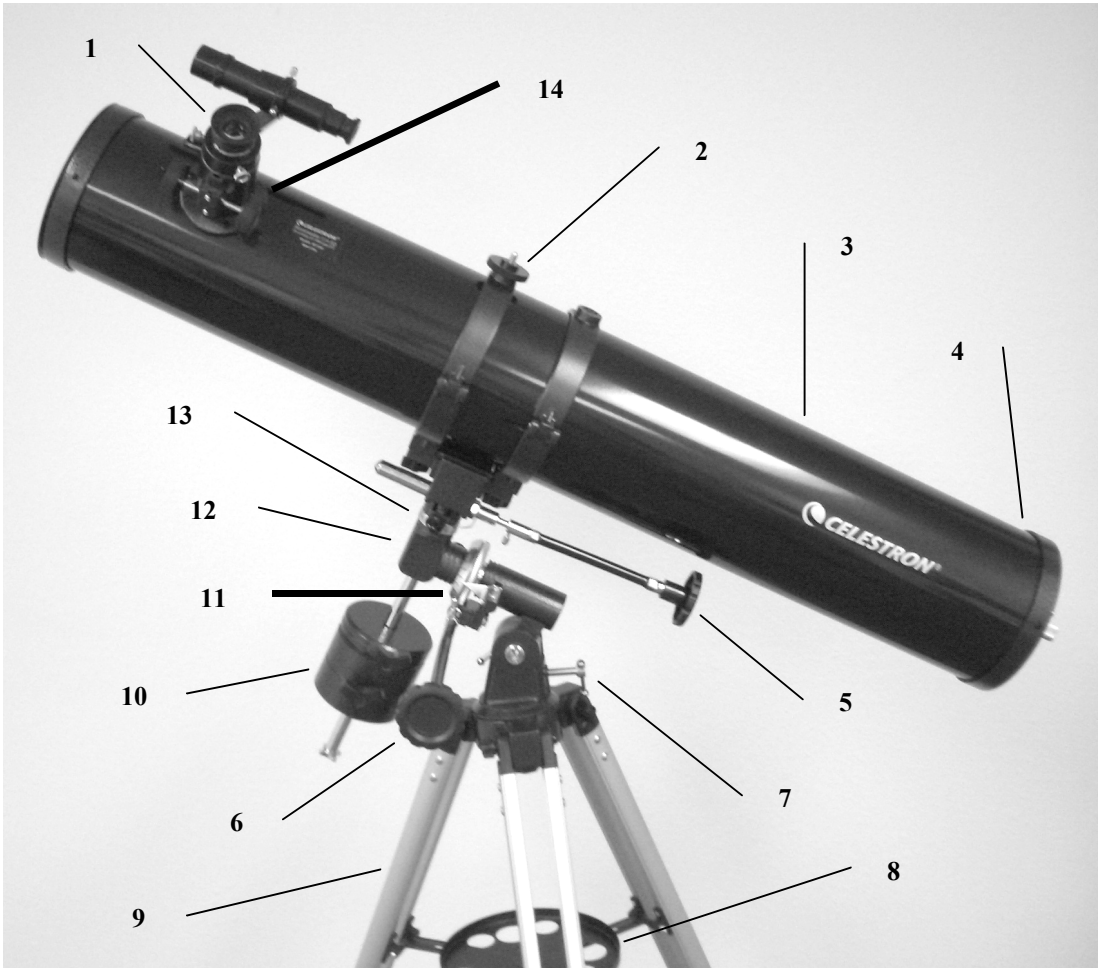


Figure 1-2 PowerSeeker 114EQ Newtonian
PowerSeeker 127EQ Newtonian Similar

1.	**Eyepiece**	**8.**	**Tripod Accessory Tray**
2.	**Tube Ring**	**9.**	**Tripod**
3.	**Telescope Optical Tube**	**10.**	**Counterweight**
4.	**Primary Mirror**	**11.**	**R.A. Setting Circle**
5.	**Dec. Slow Motion Cable**	**12.**	**Equatorial Mount**
6.	**R.A. Slow Motion Cable**	**13.**	**Dec. Setting Circle**
7.	**Latitude Adjustment Screw**	**14.**	**Focus Knob**

CELESTRON Assembly

This section covers the assembly instructions for your PowerSeeker telescope. Your telescope should be set up indoor the first time so that it is easy to identify the various parts and familiarize yourself with the correct assembly procedure before attempting it outdoor.

Each PowerSeeker comes in one box. The pieces in the box are – optical tube, tube rings (except 60EQ), German equatorial mount, counterweight bar, counterweight(s), R.A. & Dec. slow-motion cables, 4mm eyepiece – 1.25", 20mm eyepiece – 1.25" (erect image for 114EQ & 127EQ), erect image diagonal 1.25" (for 60EQ, 70EQ, and 80EQ), 3x Barlow Lens 1.25", "The Sky" Level 1 CD-ROM.

Setting up the Tripod

1. Remove the tripod from the box (Figure 2-1). The tripod comes preassembled so that the set up is very easy.
2. Stand the tripod upright and pull the tripod legs apart until each leg is fully extended and then push down slightly on the tripod leg brace (Figure 2-2). The very top of the tripod is called the tripod head.
3. Next, we will install the tripod accessory tray (Figure 2-3) onto the tripod leg brace (center of Figure 2-2).
4. On the bottom of the tripod tray is a screw attached to the center. The screw attaches into a threaded hole in the center of the tripod leg brace by turning it counterclockwise - note: pull up slightly on the tripod leg brace to make it easy to attach. Continue turning the tray until hand tight – don't over tighten the tray.

Figure 2-1

Figure 2-2

Figure 2-3

5. The tripod is now completely assembled (Figure 2-4).
6. You can extend the tripod legs to the height you desire. At the lowest level the height is 26" (66cm) and extends to 47" (119cm). You unlock the tripod leg lock knob at the bottom of each leg (Figure 2-5) by turning them counterclockwise and pull the legs out to the height you want & then lock the knob securely. A fully extended the tripod looks like the image in Figure 2-6.
7. The tripod will be the most rigid and stable at the lower heights.

Figure 2-4

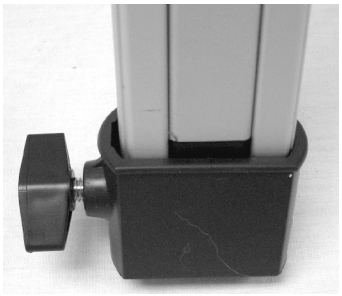


Figure 2-5

Figure 2- 6

Attaching the Equatorial Mount

The equatorial mount allows you to tilt the telescopes axis of rotation so that you can track the stars as they move across the sky. The PowerSeeker mount is a German equatorial mount that attaches to the tripod head. To attach the mount:

1. Remove the equatorial mount from the box (Figure 2-8). The mount may has one latitude adjustment screw (latitude locking bolt) attached to it. The other attaches to the threaded hole in the mount as shown in Figure 2-10.
2. The mount will attach to the tripod head and more specifically to the knob with bolt attached under the tripod head (Figure 2-7). Push the mount (large flat portion with a small tube sticking out) into the center hole of the tripod head until it is flush and hold it steady. Then, reach under the tripod head with your other hand and turn the knob counterclockwise which will thread it into the bottom of the mount. Continue turning until it is tight. The completed assembly of the mount to the tripod is seen in Figure 2-9.

Figure 2-7

Figure 2-8

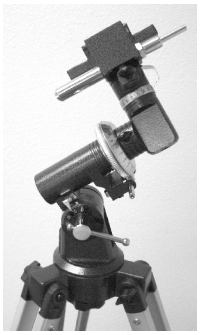


Figure 2-9

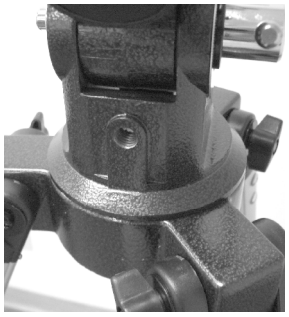


Figure 2-10

Installing the Counterweight Bar & Counterweight(s)

To properly balance the telescope, the mount comes with a counterweight bar and one or two counterweights (depending on the model you have). To install them:

1. Remove the counterweight safety screw from the counterweight bar (at the opposite end of the threaded rod) by unthreading it counterclockwise – see Figure 2-11.
2. Install the large threads of the counterweight bar into the threaded hole in the Dec. axis of the mount and turn counterclockwise-- see Figure 2-12 until it is tight. Now you are ready to attach the counterweight(s).
3. Orient the mount so that the counterweight bar points toward the ground.
4. Loosen the locking knob on the side of the counterweight so that the threads do not protrude through the center hole of the counterweight.
5. Slide the counterweight onto the counterweight bar about half way up and tighten the locking knob securely. The correct orientation of the weight is shown in Figure 2-13.
6. Slide the second counterweight (if your model has a second weight) onto the counterweight bar flush up against the first one and then lock securely.
7. Replace the safety screw and thread it on securely. The completed assembly is shown in Figure 2-13.

Figure 2-11

Figure 2-12

Figure 2-13

Attaching the Slow Motion Cables

The PowerSeeker mount comes with two slow motion control cables that allow you to make fine pointing adjustments to the telescope in both R.A. and Declination. To install the cables:

1. Locate the two cables with knobs on them. The longer one is for the R.A. axis and make sure the screw on each cable end does not protrude through the opening.
2. Slide the cable onto the R.A. shaft (see Figure 2-14) as far as it will go. There are two R.A. shafts, one on either side of the mount. It makes no difference which shaft you use since both work the same (except if using a motor drive). Use whichever one you find more convenient.
3. Tighten the screw on the R.A. cable to hold it securely in place.
4. The DEC slow motion cable attaches in the same manner as the R.A. cable. The shaft that the DEC slow motion knob fits over is toward the top of the mount, just below the telescope mounting platform.

Figure 2-14
R.A. Shaft on bottom below the R.A. Setting Circle Dec. Shaft on top above the Dec. Setting Circle

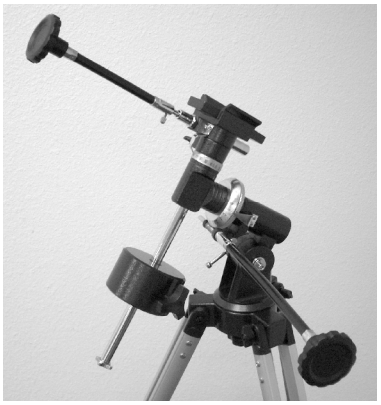


Figure 2-15
R.A. & Dec. Cables attached

Attaching the Telescope Tube to the Mount

The telescope optical tube attaches to the equatorial mount with tube rings (except on the 60EQ) supporting it to the mounting bracket at the top of the mount (Figure 2-16). For the 60EQ refractor, the tube mounts directly to the mounting bracket with the screw studs attached to the optical tube. **Before you attach the optical tube, make sure that the declination and right ascension locking knobs are tight (Figure 2-24). Then, make sure that the latitude adjustment screws (Figure 2-27) are tight.** This will ensure that the mount does not move suddenly while attaching the telescope optical tube. Also, remove the objective lens cap (refractor) or the front opening cap (Newtonian). To mount the telescope tube:

1. Remove the protective paper covering the optical tube. You will have to remove the tube rings (Figure 2-16) before removing the paper.
2. Remove the knobs from the threaded posts at the bottom of the tube rings (Figure 2-16).
3. Now put the posts through the holes in the top of the mount platform (Figure 2-17) and put the knobs back on and tighten and they will look like Figure 2-18.
4. Open the tube rings (loosen the large chromed knobs) so that the optical tube can be put on.
5. Hold the optical tube carefully with one hand and center in the tube rings and close the rings and latch and tighten the knurled knobs of the tube rings which will look like Figure 2-19.
6. Note that you could attach the tube rings to the optical tube first and then attach to the mounting platform on the equatorial mount as this is a personal preference.

NOTE: Never loosen any of the knobs on the telescope tube or mount other than the R.A. and DEC knobs.

Hint: For maximum rigidity of the telescope and mount, make sure the knobs/screws holding the tripod legs to the tripod head are tight.

Figure 2-16

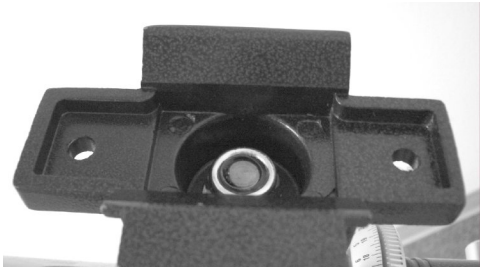


Figure 2-17

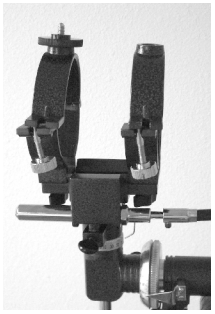


Figure 2-18

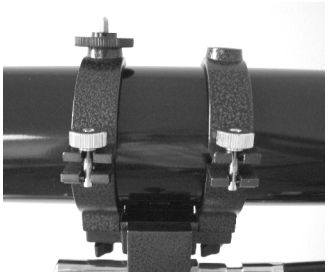


Figure 2-19

Installing the Diagonal & Eyepiece (Refractor)

The diagonal is a prism that diverts the light at a right angle to the light path of the refractor. This allows you to observe in a position that is more comfortable than if you had to look straight through. This diagonal is an erect image model that corrects the image to be right side up and oriented correctly left-to-right which is much easier to use for terrestrial observing. Also, the diagonal can be rotated to any position which is most favorable for you. To install the diagonal and eyepieces:

1. Insert the small barrel of the diagonal into the 1.25" eyepiece adapter of the focus tube on the refractor – Figure 2-20. Make sure the two thumbscrews on the eyepiece adapter do not protrude into the focuser tube before installation and the plug up cap is removed from the eyepiece adapter.
2. Put the chrome barrel end of one of the eyepieces into the diagonal and tighten the thumb screw. Again, when doing this make sure the thumb screw is not protruding into the diagonal before inserting the eyepiece.
3. The eyepieces can be changed to other focal lengths by reversing the procedure in step 2 above.

Figure 2-20

Installing the Eyepiece on the Newtonian

The eyepiece (or ocular) is an optical element that magnifies the image focused by the telescope. Without the eyepiece it would be impossible to use the telescope visually. Eyepieces are commonly referred to by focal length and barrel diameter. The longer focal length (i.e., the larger the number) the lower the eyepiece magnification (i.e., power). Generally, you will use low-to-moderate power when viewing. For more information on how to determine power, see the section on "Calculating Magnification". The eyepiece fits directly into the focuser of the Newtonian. To attach the eyepieces:

1. Make sure the thumbscrews are not protruding into the focuser tube. Then, insert the chrome barrel of the eyepieces into the focus tube (remove the plug up cap of the focuser first) and tighten the thumbscrews – see Figure 2-21.
2. The 20mm eyepiece is called an erecting eyepiece since it corrects the image so it is right side up and corrected left to right. This makes the telescope useful for terrestrial viewing.
3. The eyepieces can be changed by reversing the procedure as described above.

Figure 2-21

Installing the Finderscope

To install the finderscope:

1. Locate the finderscope (it will be mounted inside the finderscope bracket) – see Figures 1-1 and 1-2.
2. Remove the knurled nuts on the threaded posts on the optical tube – see Figure 2-22.
3. Mount the finderscope bracket by placing it over the posts protruding from the optical tube and then holding it in place thread on the knurled nuts and tighten them down – note that the finderscope should be oriented so that the larger diameter lens is facing toward the front of the optical tube.
4. Remove the lens caps from both ends of the finderscope.

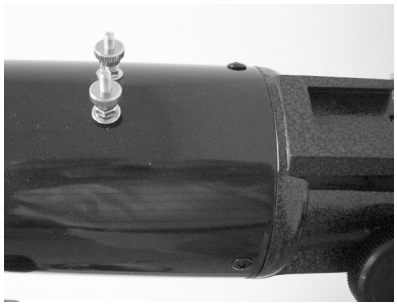


Figure 2-22

Aligning the Finderscope

Use the following steps to align the finderscope:

1. Locate a distant daytime object and center it in a low power (20mm) eyepiece in the main telescope.
2. Look through the finderscope (the eyepiece end of the finderscope) and take notice of the position of the same object.
3. Without moving the main telescope, turn the adjustment thumb screws located around the finderscope bracket until the crosshairs of the finderscope are centered on the object chosen with the main telescope.

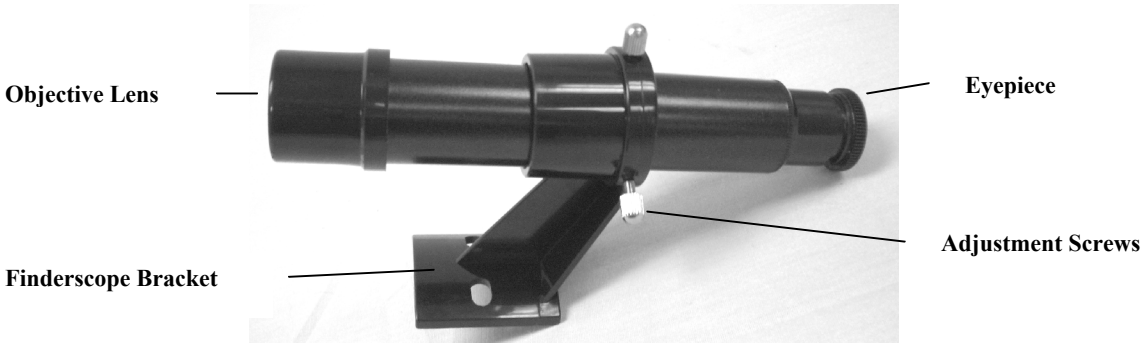


Figure 2-22a Finderscope with Bracket

Installing and Using the Barlow Lens

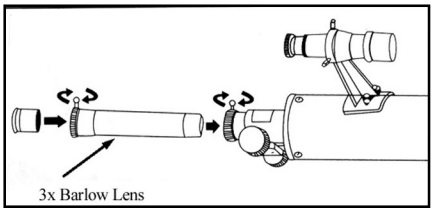


Figure 2-23

Your telescope also comes with a 3x Barlow Lens which triples the magnifying power of each eyepiece. However, the greatly magnified images should only be used under ideal conditions – see the "Calculating Magnification" section of this manual.

To use the Barlow lens with refractors, remove the diagonal and insert the Barlow directly into the focuser tube. You then insert an eyepiece into the Barlow lens for viewing. You can also, insert the diagonal into the Barlow lens and then use an eyepiece in the diagonal but you may not be able to reach focus with all eyepieces.

For Newtonian telescopes, insert the Barlow directly into the focuser. Then, insert an eyepiece into the Barlow lens.

Note: Start by using a low power eyepiece as it will be easier to focus.

3x Barlow Lens Magnification					
	60EQ	70EQ	80EQ	114EQ	127EQ
w/20mm Eyepiece	135x	105x	135x	135x	150x
w/4mm Eyepiece	675x	525x	675x	675x	450x

Moving the Telescope Manually

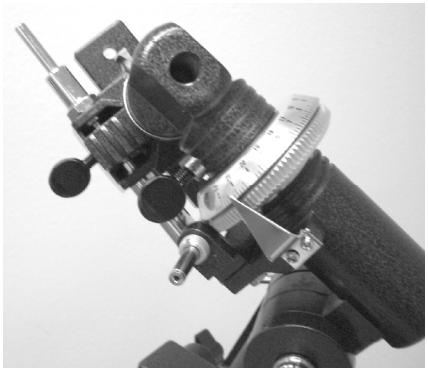


Figure 2-24
Dec. Lock Knob on top of Dec.circle & R.A. Lock Knob on top of R.A. circle

In order to properly balance your telescope, you will need to move your telescope manually at various portions of the sky to observe different objects. To make rough adjustments, loosen the R.A. and Dec. locking knobs slightly and move the telescope in the desired direction. To make fine adjustments, when the knobs are locked you turn the slow motion control cables.

Both the R.A. and Dec. axis have locking knobs to clutch down each axis of the telescope. To loosen the clutches on the telescope, unlock the locking knobs.

Balancing the Mount in R.A.

To eliminate undue stress on the mount, the telescope should be properly balanced around the polar axis. In addition, proper balancing is crucial for accurate tracking if using an optional motor drive. To balance the mount:

1. Release the R.A. lock knob (see figure 2-24) and position the telescope off to one side of the mount (make sure that the dovetail mounting bracket knob is tight). The counterweight bar will extend horizontally on the opposite side of the mount (see figure 2-25).
2. Release the telescope — **GRADUALLY** — to see which way the telescope "rolls" or falls.
3. Loosen the counterweight locking knob on the counterweights (one at a time if you have two counterweights) while holding the counterweight(s) and slowly release them.
4. Move the counterweights to a point where they balance the telescope (i.e., it remains stationary when the R.A. lock knob is released).
5. Tighten the locking knobs to hold the counterweights in place.

Balancing the Mount in Dec.

The telescope should also be balanced on the declination axis to prevent any sudden motions when the Dec. lock knob (Fig 2-24) is released. To balance the telescope in Dec.:

1. Release the R.A. locking knob and rotate the telescope so that it is on one side of the mount (i.e., as described in the previous section on balancing the telescope in R.A.).
2. Lock the R.A. locking knob to hold the telescope in place.
3. Release the Dec. locking knob and rotate the telescope until the tube is parallel to the ground (figure 2-26).
4. Release the tube — **GRADUALLY** — to see which way it rotates around the declination axis. **DO NOT LET GO OF THE TELESCOPE TUBE COMPLETELY!**
5. For the 70EQ, 80EQ, 114EQ, and 127EQ --- while holding the optical tube with one hand, loosen the knurled screws that hold the telescope tube inside the tube rings and slide the telescope either forwards or backwards until it remains stationary when the Dec. lock knob is released. There is no adjustment for the 60EQ as it is fixed in place on the mounting bracket of the mount.
6. Tighten the tube ring screws firmly to hold the telescope in place.

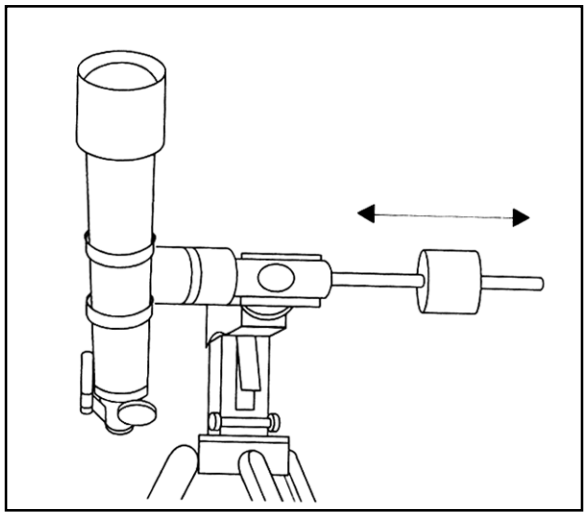


Figure 2-25

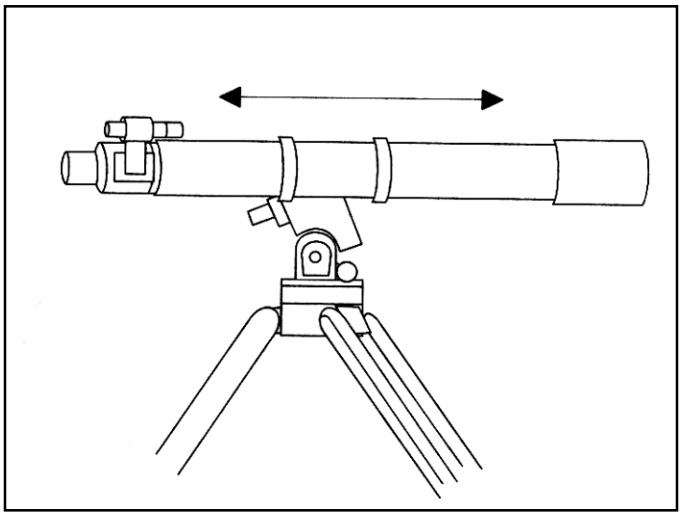


Figure 2-26

Adjusting the Equatorial Mount

In order for a motor drive to track accurately, the telescope's axis of rotation must be parallel to the Earth's axis of rotation, a process known as polar alignment. Polar alignment is achieved NOT by moving the telescope in R.A. or Dec., but by adjusting the mount vertically, which is called altitude. This section simply covers the correct movement of the telescope during the polar alignment process. The actual process of polar alignment, that is making the telescope's axis of rotation parallel to the Earth's, is described later in this manual in the section on "Polar Alignment."

Adjusting the Mount in Altitude

- To increase the latitude of the polar axis, loosen the front latitude adjustment screw (locking bolt) slightly -- Figure 2-27.

- To increase or decrease the latitude of the polar axis, tighten or loosen the front latitude adjustment screw. Then, tighten the front latitude adjustment screw (locking bolt) securely.

The latitude adjustment on the PowerSeeker mount has a range from approximately 20° to 60°.

It is best to always make final adjustments in altitude by moving the mount against gravity (i.e. using the rear latitude adjustment screw to raise the mount). To do this you should loosen both latitude adjustment screws and manually push the front of the mount down as far as it will go. Then tighten the rear adjustment screw to raise the mount to the desired latitude.

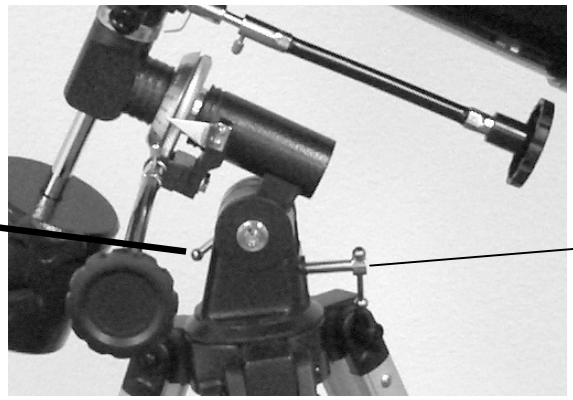


Figure 2-27

CELESTRON

Telescope Basics

A telescope is an instrument that collects and focuses light. The nature of the optical design determines how the light is focused. Some telescopes, known as refractors, use lenses, and other telescopes, known as reflectors (Newtonians), use mirrors.

Developed in the early 1600s, the **refractor** is the oldest telescope design. It derives its name from the method it uses to focus incoming light rays. The refractor uses a lens to bend or refract incoming light rays, hence the name (see Figure 3-1). Early designs used single element lenses. However, the single lens acts like a prism and breaks light down into the colors of the rainbow, a phenomenon known as chromatic aberration. To get around this problem, a two-element lens, known as an achromat, was introduced. Each element has a different index of refraction allowing two different wavelengths of light to be focused at the same point. Most two-element lenses, usually made of crown and flint glasses, are corrected for red and green light. Blue light may still be focused at a slightly different point.

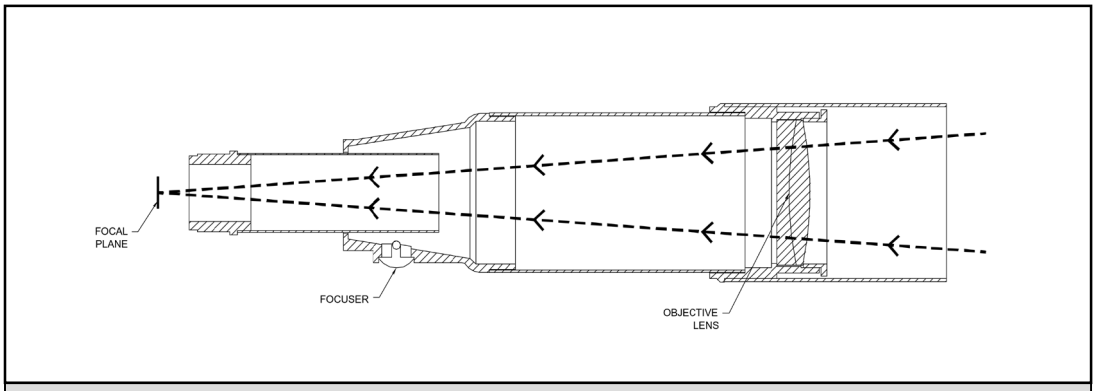


Figure 3-1
A cutaway view of the light path of the Refractor optical design

A **Newtonian** reflector uses a single concave mirror as its primary. Light enters the tube traveling to the mirror at the back end. There light is bent forward in the tube to a single point, its focal point. Since putting your head in front of the telescope to look at the image with an eyepiece would keep the reflector from working, a flat mirror called a *diagonal* intercepts the light and points it out the side of the tube at right angles to the tube. The eyepiece is placed there for easy viewing.

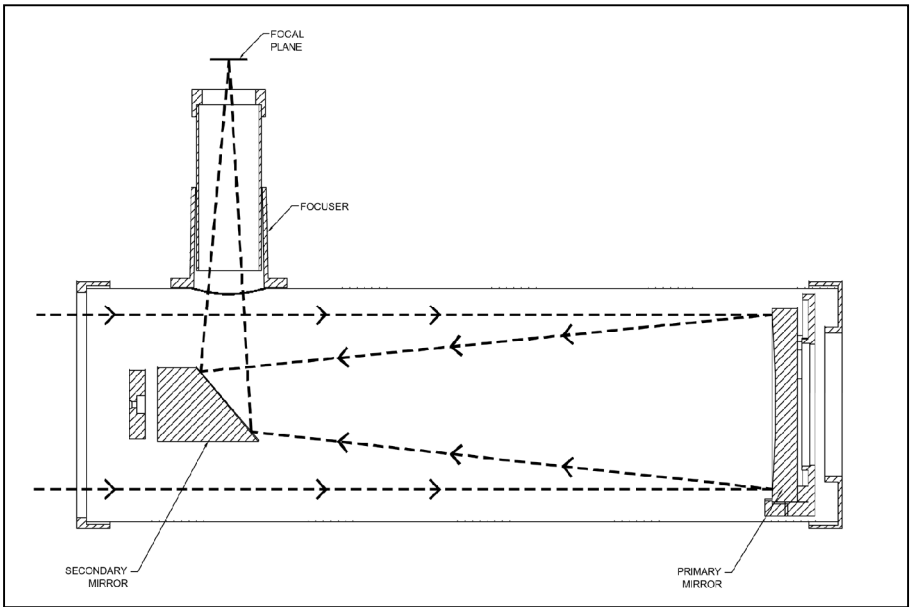


Figure 3-2
Cutaway view of the light path of the Newtonian optical design

Newtonian Reflector telescopes replace heavy lenses with mirrors to collect and focus the light, providing much more light-gathering power for the money spent. Because the light path is intercepted and reflected out to the side, you can have focal lengths up to 1000mm and still enjoy a telescope that is relatively compact and portable. A Newtonian Reflector telescope offers such impressive light-gathering characteristics you can take a serious interest in deep space astronomy even on a modest budget. Newtonian Reflector telescopes do require more care and maintenance because the primary mirror is exposed to air and dust. However, this small drawback does not hamper this type of telescope's popularity with those who want an economical telescope that can still resolve faint, distant objects.

Image Orientation

The image orientation changes depending on how the eyepiece is inserted into the telescope. When using a star diagonal with refractors, the image is right-side-up, but reversed from left-to-right (i.e., mirror image). If inserting the eyepiece directly into the focuser of a refractor (i.e., without the diagonal), the image is upside-down and reversed from left-to-right (i.e., inverted). However, when using the PowerSeeker refractor and the standard erect image diagonal, the image is correctly oriented in every aspect.

Newtonian reflectors produce a right-side-up image but the image will appear rotated based on the location of the eyepiece holder in relation to the ground. However, by using the erect image eyepiece supplied with the PowerSeeker Newtonians, the image is correctly oriented

Image orientation as seen with the unaided eye & using erecting devices on refractors & Newtonians.

Reversed from left to right, as viewed using a Star Diagonal on a refractor.

Inverted image, normal with Newtonians & as viewed with eyepiece directly in a refractor.

Figure 3-3

Focusing

To focus your refractor or Newtonian telescope, simply turn the focus knob located directly below the eyepiece holder (see Figures 2-20 and 2-21). Turning the knob clockwise allows you to focus on an object that is farther than the one you are currently observing. Turning the knob counterclockwise from you allows you to focus on an object closer than the one you are currently observing.

Note: If you wear corrective lenses (specifically glasses), you may want to remove them when observing with an eyepiece attached to the telescope. However, when using a camera you should always wear corrective lenses to ensure the sharpest possible focus. If you have astigmatism, corrective lenses must be worn at all times.

Calculating Magnification

You can change the power of your telescope just by changing the eyepiece (ocular). To determine the magnification of your telescope, simply divide the focal length of the telescope by the focal length of the eyepiece used. In equation format, the formula looks like this:

$$\text{Magnification} = \frac{\text{Focal Length of Telescope (mm)}}{\text{Focal Length of Eyepiece (mm)}}$$

Let's say, for example, you are using the 20mm eyepiece that came with your telescope. To determine the magnification you divide the focal length of your telescope (the PowerSeeker 80EQ for this example has a focal length of 900mm) by the focal length of the eyepiece, 20mm. Dividing 900 by 20 yields a magnification of 45x.

Although the power is variable, each instrument under average skies has a limit to the highest useful magnification. The general rule is that 60 power can be used for every inch of aperture. For example, the PowerSeeker 80EQ is 3.1" inches in diameter. Multiplying 3.1 by 80 gives a maximum useful magnification of 189 power. Although this is the maximum useful magnification, most observing is done in the range of 20 to 35 power for every inch of aperture which is 62 to 109 times for the PowerSeeker 80EQ telescope. You can determine the magnification for your telescope the same way.

Determining Field of View

Determining the field of view is important if you want to get an idea of the angular size of the object you are observing. To calculate the actual field of view, divide the apparent field of the eyepiece (supplied by the eyepiece manufacturer) by the magnification. In equation format, the formula looks like this:

$$\text{True Angular Field} = \frac{\text{Apparent Field of Eyepiece}}{\text{Magnification}}$$

As you can see, before determining the field of view, you must calculate the magnification. Using the example in the previous section, we can determine the field of view using the same 20mm eyepiece that is supplied standard with the PowerSeeker 80EQ telescope. The 20mm eyepiece has an apparent field of view of 50°. Divide the 50° by the magnification, which is 45 power. This yields an actual (true) field of 1.1°.

To convert degrees to feet at 1,000 yards, which is more useful for terrestrial observing, simply multiply by 52.5. Continuing with our example, multiply the angular field of 1.1° by 52.5. This produces a linear field width of 58 feet at a distance of one thousand yards.

General Observing Hints

When working with any optical instrument, there are a few things to remember to ensure you get the best possible image.

- Never look through window glass. Glass found in household windows is optically imperfect, and as a result, may vary in thickness from one part of a window to the next. This inconsistency can and will affect the ability to focus your telescope. In most cases you will not be able to achieve a truly sharp image, while in some cases, you may actually see a double image.

- Never look across or over objects that are producing heat waves. This includes asphalt parking lots on hot summer days or building rooftops.

- Hazy skies, fog, and mist can also make it difficult to focus when viewing terrestrially. The amount of detail seen under these conditions is greatly reduced.

- If you wear corrective lenses (specifically glasses), you may want to remove them when observing with an eyepiece attached to the telescope. When using a camera, however, you should always wear corrective lenses to ensure the sharpest possible focus. If you have astigmatism, corrective lenses must be worn at all times.

CELESTRON

Astronomy Basics

Up to this point, this manual covered the assembly and basic operation of your telescope. However, to understand your telescope more thoroughly, you need to know a little about the night sky. This section deals with observational astronomy in general and includes information on the night sky and polar alignment.

The Celestial Coordinate System

To help find objects in the sky, astronomers use a celestial coordinate system that is similar to our geographical co-ordinate system here on Earth. The celestial coordinate system has poles, lines of longitude and latitude, and an equator. For the most part, these remain fixed against the background stars.

The celestial equator runs 360 degrees around the Earth and separates the northern celestial hemisphere from the southern. Like the Earth's equator, it bears a reading of zero degrees. On Earth this would be latitude. However, in the sky this is referred to as declination, or DEC for short. Lines of declination are named for their angular distance above and below the celestial equator. The lines are broken down into degrees, minutes of arc, and seconds of arc. Declination readings south of the equator carry a minus sign (-) in front of the coordinate and those north of the celestial equator are either blank (i.e., no designation) or preceded by a plus sign (+).

The celestial equivalent of longitude is called Right Ascension, or R.A. for short. Like the Earth's lines of longitude, they run from pole to pole and are evenly spaced 15 degrees apart. Although the longitude lines are separated by an angular distance, they are also a measure of time. Each line of longitude is one hour apart from the next. Since the Earth rotates once every 24 hours, there are 24 lines total. As a result, the R.A. coordinates are marked off in units of time. It begins with an arbitrary point in the constellation of Pisces designated as 0 hours, 0 minutes, 0 seconds. All other points are designated by how far (i.e., how long) they lag behind this coordinate after it passes overhead moving toward the west.

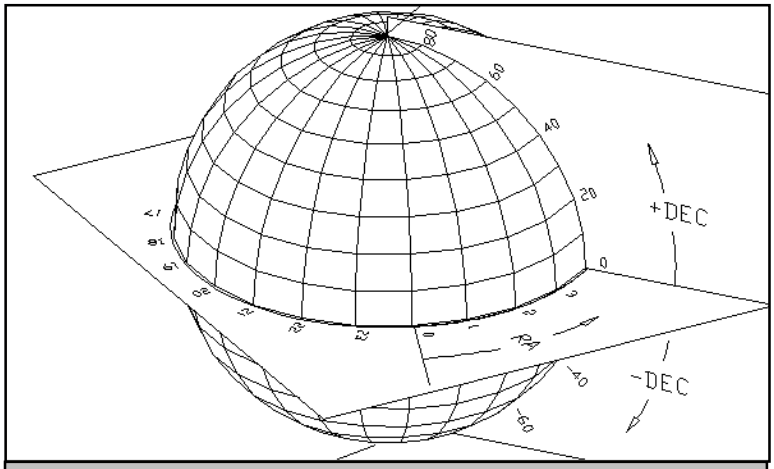


Figure 4-1
The celestial sphere seen from the outside showing R.A. and DEC.

Motion of the Stars

The daily motion of the Sun across the sky is familiar to even the most casual observer. This daily trek is not the Sun moving as early astronomers thought, but the result of the Earth's rotation. The Earth's rotation also causes the stars to do the same, scribing out a large circle as the Earth completes one rotation. The size of the circular path a star follows depends on where it is in the sky. Stars near the celestial equator form the largest circles rising in the east and setting in the west. Moving toward the north celestial pole, the point around which the stars in the northern hemisphere appear to rotate, these circles become smaller. Stars in the mid-celestial latitudes rise in the northeast and set in the northwest. Stars at high celestial latitudes are always above the horizon, and are said to be circumpolar because they never rise and never set. You will never see the stars complete one circle because the sunlight during the day washes out the starlight. However, part of this circular motion of stars in this region of the sky can be seen by setting up a camera on a tripod and opening the shutter for a couple hours. The timed exposure will reveal semicircles that revolve around the pole. (This description of stellar motions also applies to the southern hemisphere except all stars south of the celestial equator move around the south celestial pole.)

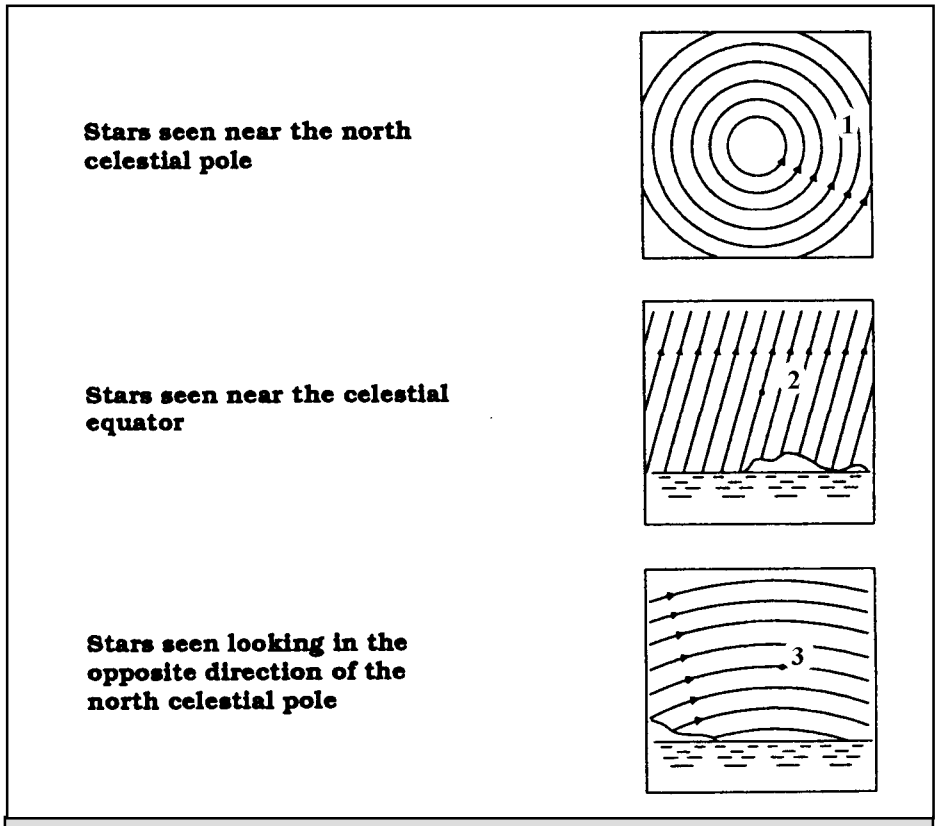

Stars seen near the north celestial pole
1
Stars seen near the celestial equator
2
Stars seen looking in the opposite direction of the north celestial pole
3

Figure 4-2
All stars appear to rotate around the celestial poles. However, the appearance of this motion varies depending on where you are looking in the sky. Near the north celestial pole the stars scribe out recognizable circles centered on the pole (1). Stars near the celestial equator also follow circular paths around the pole. But, the complete path is interrupted by the horizon. These appear to rise in the east and set in the west (2). Looking toward the opposite pole, stars curve or arc in the opposite direction scribing a circle around the opposite pole (3).

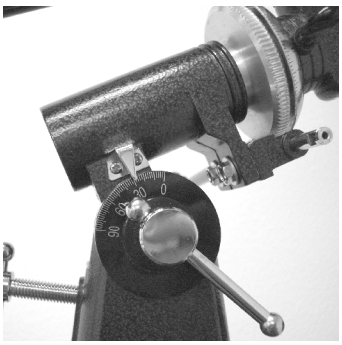


Figure 4-3

Polar Alignment with the Latitude Scale

The easiest way to polar align a telescope is with a latitude scale. Unlike other methods that require you to find the celestial pole by identifying certain stars near it, this method works off of a known constant to determine how high the polar axis should be pointed. The PowerSeeker equatorial mount can be adjusted from about 20 to 60 degrees (see figure 4-3).

The constant, mentioned above, is a relationship between your latitude and the angular distance the celestial pole is above the northern (or southern) horizon. The angular distance from the northern horizon to the north celestial pole is always equal to your latitude. To illustrate this, imagine that you are standing on the north pole, latitude +90°. The north celestial pole, which has a declination of +90°, would be directly overhead (i.e., 90 above the horizon). Now, let's say that you move one degree south — your latitude is now +89° and the celestial pole is no longer directly overhead. It has moved one degree closer toward the northern horizon. This means the pole is now 89° above the northern horizon. If you move one degree further south, the same thing happens again. You would have to travel 70 miles north or south to change your latitude by one degree. As you can see from this example, the distance from the northern horizon to the celestial pole is always equal to your latitude.

If you are observing from Los Angeles, which has a latitude of 34°, then the celestial pole is 34° above the northern horizon. All a latitude scale does then is to point the polar axis of the telescope at the right elevation above the northern (or southern) horizon.

To align your telescope:
1. Make sure the polar axis of the mount is pointing due north. Use a landmark that you know faces north.
2. Level the tripod. Leveling the tripod is only necessary if using this method of polar alignment.
3. Adjust the mount in altitude until the latitude indicator points to your latitude. Moving the mount affects the angle the polar axis is pointing. For specific information on adjusting the equatorial mount, please see the section "Adjusting the Mount."

This method can be done in daylight, thus eliminating the need to fumble around in the dark. Although this method does **NOT** put you directly on the pole, it will limit the number of corrections you will make when tracking an object.

Pointing at Polaris

This method utilizes Polaris as a guidepost to the north celestial pole. Since Polaris is less than a degree from the celestial pole, you can simply point the polar axis of your telescope at Polaris. Although this is by no means perfect alignment, it does get you within one degree. Unlike the previous method, this must be done in the dark when Polaris is visible.

1. Set the telescope up so that the polar axis is pointing north – see Figure 4-6.
2. Loosen the Dec. clutch knob and move the telescope so that the tube is parallel to the polar axis. When this is done, the declination setting circle will read +90°. If the declination setting circle is not aligned, move the telescope so that the tube is parallel to the polar axis.
3. Adjust the mount in altitude and/or azimuth until Polaris is in the field of view of the finder.

Remember, while Polar aligning, do NOT move the telescope in R.A. or DEC. You do not want to move the telescope itself, but the polar axis. The telescope is used simply to see where the polar axis is pointing.

Like the previous method, this gets you close to the pole but not directly on it. The following method helps improve your accuracy for more serious observations and photography.

Finding the North Celestial Pole

In each hemisphere, there is a point in the sky around which all the other stars appear to rotate. These points are called the celestial poles and are named for the hemisphere in which they reside. For example, in the northern hemisphere all stars move around the north celestial pole. When the telescope's polar axis is pointed at the celestial pole, it is parallel to the Earth's rotational axis.

Many methods of polar alignment require that you know how to find the celestial pole by identifying stars in the area. For those in the northern hemisphere, finding the celestial pole is not too difficult. Fortunately, we have a naked eye star less than a degree away. This star, Polaris, is the end star in the handle of the Little Dipper. Since the Little Dipper (technically called Ursa Minor) is not one of the brightest constellations in the sky, it may be difficult to locate from urban areas. If this is the case, use the two end stars in the bowl of the Big Dipper (the pointer stars). Draw an imaginary line through them toward the Little Dipper. They point to Polaris (see Figure 4-5). The position of the Big Dipper (Ursa Major) changes during the year and throughout the course of the night (see Figure 4-4). When the Big Dipper is low in the sky (i.e., near the horizon), it may be difficult to locate. During these times, look for Cassiopeia (see Figure 4-5). Observers in the southern hemisphere are not as fortunate as those in the northern hemisphere. The stars around the south celestial pole are not nearly as bright as those around the north. The closest star that is relatively bright is Sigma Octantis. This star is just within naked eye limit (magnitude 5.5) and lies about 59 arc minutes from the pole.

Definition:The north celestial pole is the point in the northern hemisphere around which all stars appear to rotate. The counterpart in the southern hemisphere is referred to as the south celestial pole.

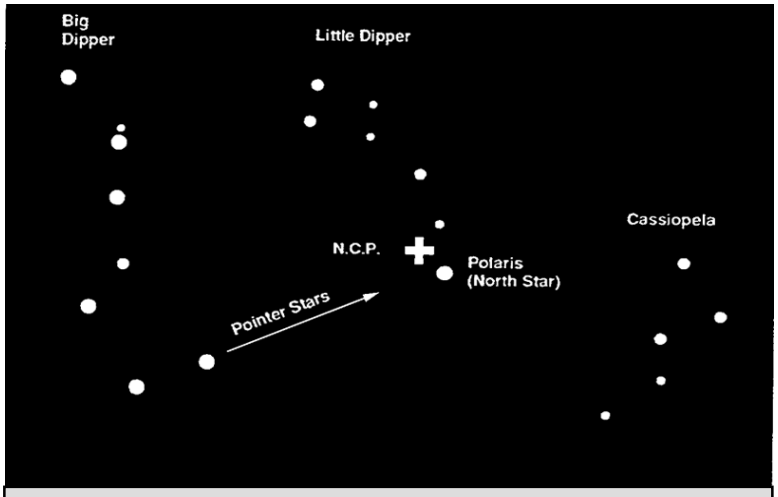


Figure 4-5
The two stars in the front of the bowl of the Big Dipper point to Polaris which is less than one degree from the true (north) celestial pole. Cassiopeia, the "W" shaped constellation, is on the opposite side of the pole from the Big Dipper. The North Celestial Pole (N.C.P.) is marked by the "+" sign.

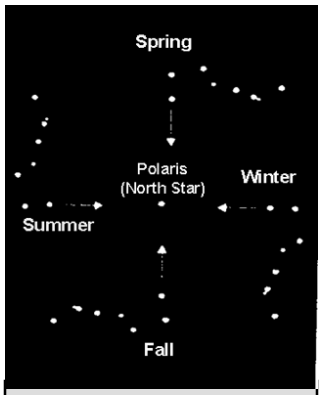


Figure 4-4
The position of the Big Dipper changes throughout the year and the night.

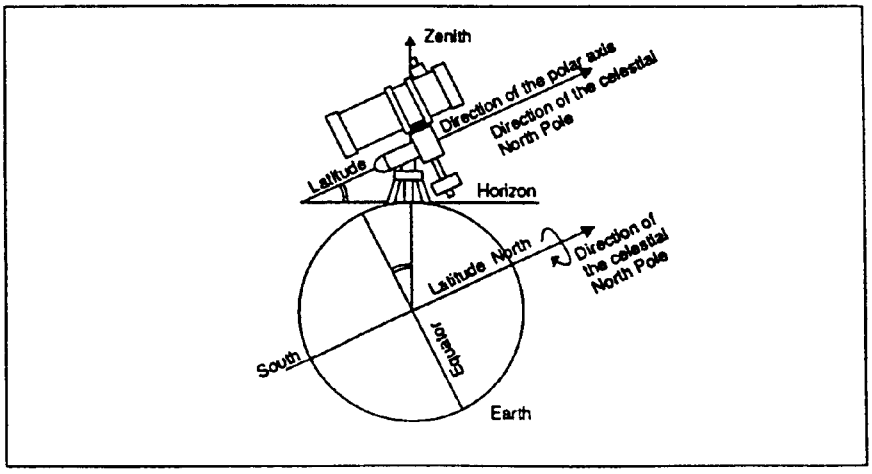


Figure 4-6
Aligning the equatorial mount to the polar axis of the Earth

Polar Alignment in the Southern Hemisphere

Polar alignment to the South Celestial Pole (SCP) is a little more challenging due to the fact that there is no very bright star close to it like Polaris is in the NCP. There are various ways to polar align your telescope and for casual observing the methods below are adequate and will get you reasonably close to the SCP.

Polar Alignment with the Latitude Scale

The easiest way to polar align a telescope is with a latitude scale. Unlike other methods that require you to find the celestial pole by identifying certain stars near it, this method works off of a known constant to determine how high the polar axis should be pointed.

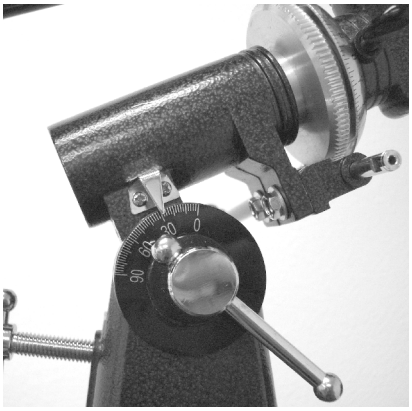


Figure 4-7

The constant, mentioned above, is a relationship between your latitude and the angular distance the celestial pole is above the southern horizon. The angular distance from the southern horizon to the south celestial pole is always equal to your latitude. To illustrate this, imagine that you are standing on the south pole, latitude -90°. The south celestial pole, which has a declination of -90°, would be directly overhead (i.e., 90° above the horizon). Now, let's say that you move one degree north — your latitude is now -89° and the celestial pole is no longer directly overhead. It has moved one degree closer toward the southern horizon. This means the pole is now 89° above the southern horizon. If you move one degree further north, the same thing happens again. You would have to travel 70 miles north or south to change your latitude by one degree. As you can see from this example, the distance from the southern horizon to the celestial pole is always equal to your latitude.

If you are observing from Sydney, which has a latitude of -34°, then the celestial pole is 34° above the southern horizon. All a latitude scale does then is to point the polar axis of the telescope at the right elevation above the southern horizon. To align your telescope:

1. Make sure the polar axis of the mount is pointing due south. Use a landmark that you know faces south.
2. Level the tripod. Leveling the tripod is only necessary if using this method of polar alignment.
3. Adjust the mount in altitude until the latitude indicator points to your latitude. Moving the mount affects the angle the polar axis is pointing. For specific information on adjusting the equatorial mount, please see the section "Adjusting the Mount" in your telescope manual.
4. If the above is done correctly, you should be able to observe near the pole through the finderscope and a low power eyepiece.

This method can be done in daylight, thus eliminating the need to fumble around in the dark. Although this method does **NOT** put you directly on the pole, it will limit the number of corrections you will make when tracking an object.

Pointing at Sigma Octantis

This method utilizes Sigma Octantis as a guidepost to the celestial pole. Since Sigma Octantis is about 1° degree from the south celestial pole, you can simply point the polar axis of your telescope at Sigma Octantis. Although this is by no means perfect alignment, it does get you within one degree. Unlike the previous method, this must be done in the dark when Sigma Octantis is visible. Sigma Octantis has a magnitude of 5.5 and may be difficult to see and a binocular may be helpful as well as the finderscope.

1. Set the telescope up so that the polar axis is pointing south.
2. Loosen the DEC clutch knob and move the telescope so that the tube is parallel to the polar axis. When this is done, the declination setting circle will read 90°. If the declination setting circle is not aligned, move the telescope so that the tube is parallel to the polar axis.
3. Adjust the mount in altitude and/or azimuth until Sigma Octantis is in the field of view of the finder.
4. If the above is done correctly, you should be able to observe near the pole through the finderscope and a low power eyepiece.

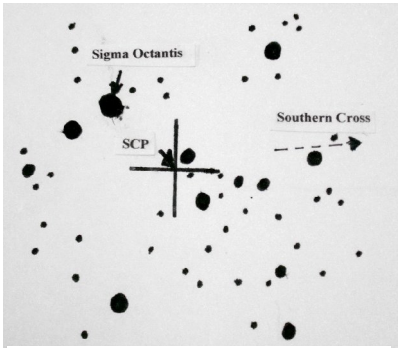


Figure 4-8

Remember, while Polar aligning, do NOT move the telescope in R.A. or DEC. You do not want to move the telescope itself, but the polar axis. The telescope is used simply to see where the polar axis is pointing.

Like the previous method, this gets you close to the pole but not directly on it.

Finding the South Celestial Pole (SCP)

This method helps improve your polar alignment and gets you closer to the pole that the above methods. This will improve your accuracy for more serious observations and photography.

In each hemisphere, there is a point in the sky around which all the other stars appear to rotate. These points are called the celestial poles and are named for the hemisphere in which they reside. For example, in the southern hemisphere all stars move around the south celestial pole. When the telescope's polar axis is pointed at the celestial pole, it is parallel to the Earth's rotational axis.

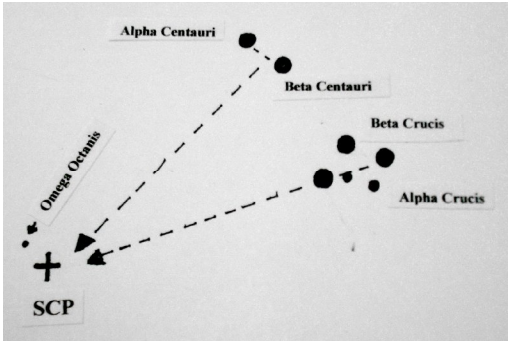


Figure 4-9

Many methods of polar alignment require that you know how to find the celestial pole by identifying stars in the area. Observers in the southern hemisphere are not as fortunate as those in the northern hemisphere. The stars around the south celestial pole are not nearly as bright as those around the north celestial pole. The closest star that is relatively bright is Sigma Octantis. This star is just within naked eye limit (magnitude 5.5) and lies about 1° from the south celestial pole but can be difficult to locate.

Therefore, with this method, you will use star patterns to find the south celestial pole. Draw an imaginary line toward the SCP through Alpha Crucis and Beta Crucis (which are in the Southern Cross). Draw another imaginary line toward the SCP at a right angle to a line connecting Alpha Centauri and Beta Centauri. The intersecting of these two imaginary lines will point you close to the south celestial pole.

Aligning the Setting Circles

Before you can use the setting circles to find objects in the sky you need to align the R.A. setting circle which is incremented in minutes. The declination setting circle is scaled in degrees and it is factory set and should not need any adjustments. On the R.A. setting circle there are two sets of numbers on the dial – one for the northern hemisphere (top) and one for the southern hemisphere (bottom).

Figure 4-10
Dec. Circle @ top and R.A. Circle @ bottom

In order to align the R.A. setting circle, you will need to know the names of a few of the brightest stars in the sky. If you don't, they can be learned by using the Celestron Sky Maps (#93722) or consulting a current astronomy magazine.

To align the R.A. setting circle:

1. Locate a bright star near the celestial equator. The farther you are from the celestial pole the better your reading on the R.A. setting circle will be. The star you choose to align the setting circle with should be a bright one whose coordinates are known and easy to look up.
2. Center the star in the finderscope.
3. Look through the main telescope and see if the star is in the field. If not, find it and center it.
4. Look up the coordinates of the star.
5. Rotate the circle until the proper coordinate lines up with the R.A. indicator. The R.A. setting circle should rotate freely.

NOTE: Because the R.A. setting circle does **NOT** move as the telescope moves in R.A., the setting circle must be aligned each time you want to use it to find an object. However, you do not need to use a star each time. Instead, you can use the coordinates of the object you are currently observing.

Once the circles are aligned you can use them to find any objects with known coordinates. The accuracy of your setting circles is directly related to the accuracy of your polar alignment.

1. Select an object to observe. Use a seasonal star chart to make sure the object you chose is above the horizon. As you become more familiar with the night sky, this will no longer be necessary.
2. Look up the coordinates in a star atlas or reference book.
3. Hold the telescope and release the Dec. lock knob.
4. Move the telescope in declination until the indicator is pointing at the correct declination coordinate.
5. Lock the Dec. lock knob to prevent the telescope from moving.
6. Hold the telescope and release the R.A. lock knob.
7. Move the telescope in R.A. until the indicator points to the correct coordinate.
8. Lock the R.A. lock knob to prevent the telescope from slipping in R.A.
9. Look through the finderscope to see if you have located the object and center the object in the finderscope.
10. Look in the main optics and the object should be there. For some of the fainter objects, you may not be able to see them in the finderscope. When this happens, it is a good idea to have a star chart of the area so that you can "star hop" through the field to your target.
11. This process can be repeated for each object throughout any given night.

Motor Drive

To allow tracking of celestial objects, Celestron offers a single axis DC motor drive for the PowerSeeker equatorial mount. Once polar aligned, the motor drive will accurately track objects in Right Ascension as they move across the sky. Only minor adjustments in Declination will be necessary to keep celestial objects centered in the eyepiece for long periods of time. Some models come standard with this motor drive and it is sold as an optional accessory (Model # 93514) for other models.

Installation of the Motor Drive – for those purchasing it as an optional accessory.

The motor drive attaches to the PowerSeeker equatorial mount via a flexible coupler that mounts to the R.A. slow motion shaft and a motor bracket that holds the motor in place. To install the motor drive see the description and photos below:

1. Make sure the R.A. slow motion cable is attached to the R.A. shaft opposite of the latitude scale.
2. Remove the Allen head bolt located on the side of the polar shaft.
3. Slide the open end of the flexible motor coupler over the R.A. shaft. Make sure that the screw on the flexible motor coupler is positioned over the flat portion of the R.A. shaft.
4. Tighten the motor coupler screw with a flathead screwdriver.
5. Rotate the motor on the shaft until the slotted cutout on the motor bracket aligns with the threaded hole in the center of the mount's latitude pivot axis.
6. Place the Allen head bolt through the motor bracket and thread it into the hole on the side of the pivot axis. Then, tighten the bolt with an Allen wrench.

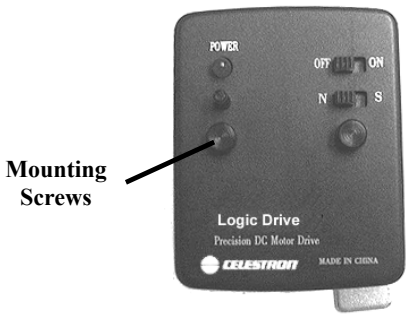


Figure 4-11

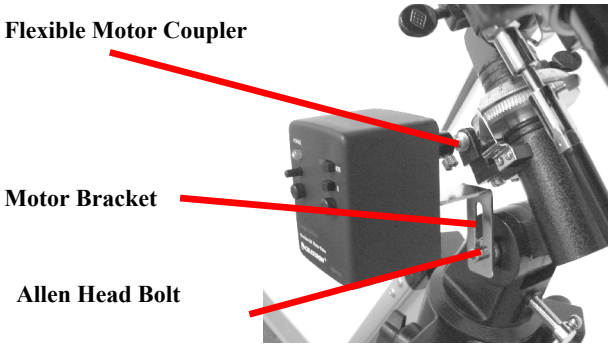


Figure 4-12

Operating the Motor Drive

The motor drive is powered by one 9-volt alkaline battery. This can power the drive for up to 40 hours, depending on motor speed setting and ambient temperature. The battery should be installed already but if not (or replacing the battery), unscrew the two mounting screws – Figure 4-11. Remove the control panel plate from the motor assembly and then remove the motor bracket from the motor. Then, you will be able to get to the battery connected to cables for installing or replacing. Finally, reverse all steps to remount the motor drive to the mount.

The motor drive is equipped with a speed rate regulator (in Figure 4-11 it is above the mounting screw) that allows the motor drive to track at a faster or slower speed. This is useful when observing non-stellar objects like the moon or Sun which travel at a slightly different rate than the stars. To change the speed of the motor, slide the On/Off switch to the "ON" position and the red power indicator light will illuminate. Then, turn the speed rate regulator knob clockwise to increase the speed of the motor and counterclockwise to decrease the speed.

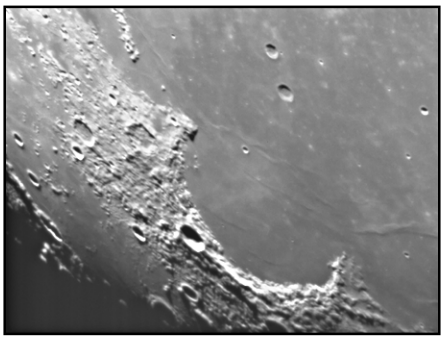
To determine the proper rate of speed, the telescope should be roughly polar aligned. Find a star on the celestial equator (approximately 0° declination) and center it in a low power eyepiece. Now turn the drive on and let the telescope track for 1 or 2 minutes. If after a few minutes, the star drifts to the West, the motor is tracking too slowly and you should increase the motor speed. If the star is drifting to the East, then decrease the motor speed. Repeat this process until the star remains centered in the eyepiece for several minutes. Remember to ignore any star drift in declination.

The drive also has a "N/S" switch to be set if operating in the Northern or Southern Hemishere.

CELESTRON Celestial Observing

With your telescope set up, you are ready to use it for observing. This section covers visual observing hints for both solar system and deep sky objects as well as general observing conditions which will affect your ability to observe.

Observing the Moon



Often, it is tempting to look at the Moon when it is full. At this time, the face we see is fully illuminated and its light can be overpowering. In addition, little or no contrast can be seen during this phase.

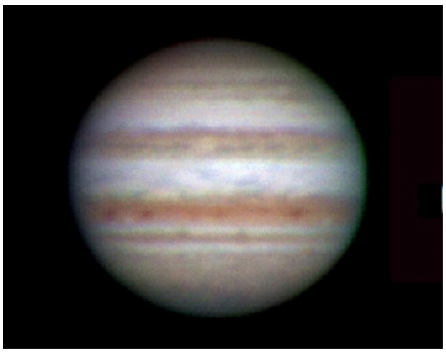
One of the best times to observe the Moon is during its partial phases (around the time of first or third quarter). Long shadows reveal a great amount of detail on the lunar surface. At low power you will be able to see most of the lunar disk at one time. Change to optional eyepieces for higher power (magnification) to focus in on a smaller area.

Lunar Observing Hints

To increase contrast and bring out detail on the lunar surface, use optional filters. A yellow filter works well at improving contrast while a neutral density or polarizing filter will reduce overall surface brightness and glare.

Observing the Planets

Other fascinating targets include the five naked eye planets. You can see Venus go through its lunar-like phases. Mars can reveal a host of surface detail and one, if not both, of its polar caps. You will be able to see the cloud belts of Jupiter and the great Red Spot (if it is visible at the time you are observing). In addition, you will also be able to see the moons of Jupiter as they orbit the giant planet. Saturn, with its beautiful rings, is easily visible at moderate power.



Planetary Observing Hints

- Remember that atmospheric conditions are usually the limiting factor on how much planetary detail will be visible. So, avoid observing the planets when they are low on the horizon or when they are directly over a source of radiating heat, such as a rooftop or chimney. See the "Seeing Conditions" section later in this section.
- To increase contrast and bring out detail on the planetary surface, try using Celestron eyepiece filters.

Observing the Sun

Although overlooked by many amateur astronomers, solar observation is both rewarding and fun. However, because the Sun is so bright, special precautions must be taken when observing our star so as not to damage your eyes or your telescope.

For safe solar viewing, use a proper solar filter that reduces the intensity of the Sun's light, making it safe to view. With a filter you can see sunspots as they move across the solar disk and faculae, which are bright patches seen near the Sun's edge.

- The best time to observe the Sun is in the early morning or late afternoon when the air is cooler.
- To center the Sun without looking into the eyepiece, watch the shadow of the telescope tube until it forms a circular shadow.

Observing Deep-Sky Objects

Deep-sky objects are simply those objects outside the boundaries of our solar system. They include star clusters, planetary nebulae, diffuse nebulae, double stars and other galaxies outside our own Milky Way. Most deep-sky objects have a large angular size. Therefore, low-to-moderate power is all you need to see them. Visually, they are too faint to reveal any of the color seen in long exposure photographs. Instead, they appear black and white. And, because of their low surface brightness, they should be observed from a dark-sky location. Light pollution around large urban areas washes out most nebulae making them difficult, if not impossible, to observe. Light Pollution Reduction filters help reduce the background sky brightness, thus increasing contrast.

Seeing Conditions

Viewing conditions affect what you can see through your telescope during an observing session. Conditions include transparency, sky illumination, and seeing. Understanding viewing conditions and the effect they have on observing will help you get the most out of your telescope.

Transparency

Transparency is the clarity of the atmosphere which is affected by clouds, moisture, and other airborne particles. Thick cumulus clouds are completely opaque while cirrus can be thin, allowing the light from the brightest stars through. Hazy skies absorb more light than clear skies making fainter objects harder to see and reducing contrast on brighter objects. Aerosols ejected into the upper atmosphere from volcanic eruptions also affect transparency. Ideal conditions are when the night sky is inky black.

Sky Illumination

General sky brightening caused by the Moon, aurora, natural airglow, and light pollution greatly affect transparency. While not a problem for the brighter stars and planets, bright skies reduce the contrast of extended nebulae making them difficult, if not impossible to see. To maximize your observing, limit deep sky viewing to moonless nights far from the light polluted skies found around major urban areas. LPR filters enhance deep sky viewing from light polluted areas by blocking unwanted light while transmitting light from certain deep sky objects. You can, on the other hand, observe planets and stars from light polluted areas or when the Moon is out.

Seeing

Seeing conditions refers to the stability of the atmosphere and directly affects the amount of fine detail seen in extended objects. The air in our atmosphere acts as a lens which bends and distorts incoming light rays. The amount of bending depends on air density. Varying temperature layers have different densities and, therefore, bend light differently. Light rays from the same object arrive slightly displaced creating an imperfect or smeared image. These atmospheric disturbances vary from time-to-time and place-to-place. The size of the air parcels compared to your aperture determines the "seeing" quality. Under good seeing conditions, fine detail is visible on the brighter planets like Jupiter and Mars, and stars are pinpoint images. Under poor seeing conditions, images are blurred and stars appear as blobs.

The conditions described here apply to both visual and photographic observations.

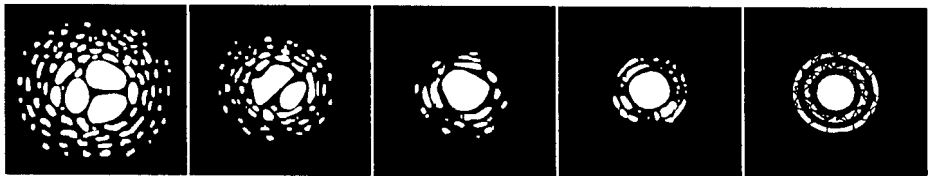


Figure 5-1
Seeing conditions directly affect image quality. These drawings represent a point source (i.e., star) under bad seeing conditions (left) to excellent conditions (right). Most often, seeing conditions produce images that lie somewhere between these two extremes.

CELESTRON Astrophotography

The PowerSeeker series of telescopes was designed for visual observing. After looking at the night sky for a while you may want to try your hand at photography of it. There are several forms of photography possible with your telescope for celestial as well as terrestrial pursuits. Below is just a very brief discussion of some of the methods of photography available and suggest you search out various books for detailed information on the subject matter.

As a minimum you will need a digital camera or a 35mm SLR camera. Attach your camera to the telescope with:

- Digital camera – you will need the Universal Digital Camera Adapter (# 93626). The adapter allows the camera to be mounted rigidly for terrestrial as well as prime focus astrophotography.
- 35mm SLR camera – you will need to remove your lens from the camera and attach a T-Ring for your specific camera brand. Then, you will need a T-Adapter (# 93625) to attach on one end to the T-Ring and the other end to the telescope focus tube. Your telescope is now the camera lens.

Short Exposure Prime Focus Photography

Short exposure prime focus photography is the best way to begin imaging celestial objects. It is done by attaching your camera to the telescope as described in the paragraph above. A couple of points to keep in mind:

- Polar align the telescope and start the optional motor drive for tracking.
- You can image the Moon as well as the brighter planets. You will have to experiment with various settings and exposure times. Much information can be obtained from your camera instruction manual which can supplement what you can find in detailed books on the subject matter.
- Do your photography from a dark sky observing site if possible.

Piggyback Photography

Figure 6-1

For the 70EQ, 80EQ, 114EQ, and 127EQ telescopes, piggyback photography is done with a camera and its normal lens riding on top of the telescope. Through this method you can capture entire constellations and record large scale nebulae. You attach your camera to the piggyback adapter screw (Figure 6-1) located on the top of the tube mounting ring (your camera will have a threaded hole on the bottom to fit this screw). You will need to polar align the telescope and start the optional motor drive for tracking.

Planetary & Lunar Photography with Special Imagers

During the last few years a new technology has evolved which makes taking superb images of the planets and moon relatively easy and the results are truly amazing. Celestron offers the NexImage (# 93712) which is a special camera and included is software for image processing. You can capture planetary images your first night out which rivals what professionals were doing with large telescopes just a few short years ago.

CCD Imaging for Deep Sky Objects

Special cameras have been developed for taking images of deep sky images. These have evolved over the last several years to become much more economical and amateurs can take fantastic images. Several books have been written on how to get the best images possible. The technology continues to evolve with better and easier to use products on the market.

Terrestrial Photography

Your telescope makes an excellent telephoto lens for terrestrial (land) photography. You can take images of various scenic views, wildlife, nature, and just about anything. You will have to experiment with focusing, speeds, etc. to get the best image desired. You can adapt your camera per the instructions at the top of this page.

CELESTRON Telescope Maintenance

While your telescope requires little maintenance, there are a few things to remember that will ensure your telescope performs at its best.

Care and Cleaning of the Optics

Occasionally, dust and/or moisture may build up on the objective lens or primary mirror depending on which type of telescope you have. Special care should be taken when cleaning any instrument so as not to damage the optics.

If dust has built up on the optics, remove it with a brush (made of camel's hair) or a can of pressurized air. Spray at an angle to the glass surface for approximately two to four seconds. Then, use an optical cleaning solution and white tissue paper to remove any remaining debris. Apply the solution to the tissue and then apply the tissue paper to the optics. Low pressure strokes should go from the center of the lens (or mirror) to the outer portion. **Do NOT rub in circles!**

You can use a commercially made lens cleaner or mix your own. A good cleaning solution is isopropyl alcohol mixed with distilled water. The solution should be 60% isopropyl alcohol and 40% distilled water. Or, liquid dish soap diluted with water (a couple of drops per one quart of water) can be used.

Occasionally, you may experience dew build-up on the optics of your telescope during an observing session. If you want to continue observing, the dew must be removed, either with a hair dryer (on low setting) or by pointing the telescope at the ground until the dew has evaporated.

If moisture condenses on the inside of the optics, remove the accessories from the telescope. Place the telescope in a dust-free environment and point it down. This will remove the moisture from the telescope tube.

To minimize the need to clean your telescope, replace all lens covers once you have finished using it. Since the cells are NOT sealed, the covers should be placed over the openings when not in use. This will prevent contaminants from entering the optical tube.

Internal adjustments and cleaning should be done only by the Celestron repair department. If your telescope is in need of internal cleaning, please call the factory for a return authorization number and price quote.

Collimation of a Newtonian

The optical performance of most Newtonian reflecting telescopes can be optimized by re-collimating (aligning) the telescope's optics, as needed. To collimate the telescope simply means to bring its optical elements into balance. Poor collimation will result in optical aberrations and distortions.

Before collimating your telescope, take time to familiarize yourself with all its components. The primary mirror is the large mirror at the back end of the telescope tube. This mirror is adjusted by loosening and tightening the three screws, placed 120 degrees apart, at the end of the telescope tube. The secondary mirror (the small, elliptical mirror under the focuser, in the front of the tube) also has three adjustment screws (you will need optional tools (described below) to perform collimation. To determine if your telescope needs collimation first point your telescope toward a bright wall or blue sky outside.

Aligning the Secondary Mirror

The following describes the procedure for daytime collimation of your telescope using the optional Newtonian Collimation Tool (#94183) offered by Celestron. To collimate the telescope without the Collimation Tool, read the following section on night time star collimation. For very precise collimation, the optional Collimation Eyepiece 1 ¼" (# 94182) is offered.

If you have an eyepiece in the focuser, remove it. Rack the focuser tube in completely, using the focusing knobs, until its silver tube is no longer visible. You will be looking through the focuser at a reflection of the secondary mirror, projected from the primary mirror. During this step, ignore the silhouetted reflection from the primary mirror. Insert the collimating cap into the focuser and look through it. With the focus pulled in all the way, you should be able to see the entire primary mirror reflected in the secondary mirror. If the primary mirror is not centered in the secondary mirror, adjust the secondary mirror screws by alternately tightening and loosening them until the periphery of the primary mirror is centered in your view. DO NOT loosen or tighten the center screw in the secondary mirror support, because it maintains proper mirror position.

Aligning the Primary Mirror

Now adjust the primary mirror screws to re-center the reflection of the small secondary mirror, so it's silhouetted against the view of the primary. As you look into the focuser, silhouettes of the mirrors should look concentric. Repeat steps one and two until you have achieved this.

Remove the collimating cap and look into the focuser, where you should see the reflection of your eye in the secondary mirror.

Newtonian collimation views as seen through the focuser using the collimation cap

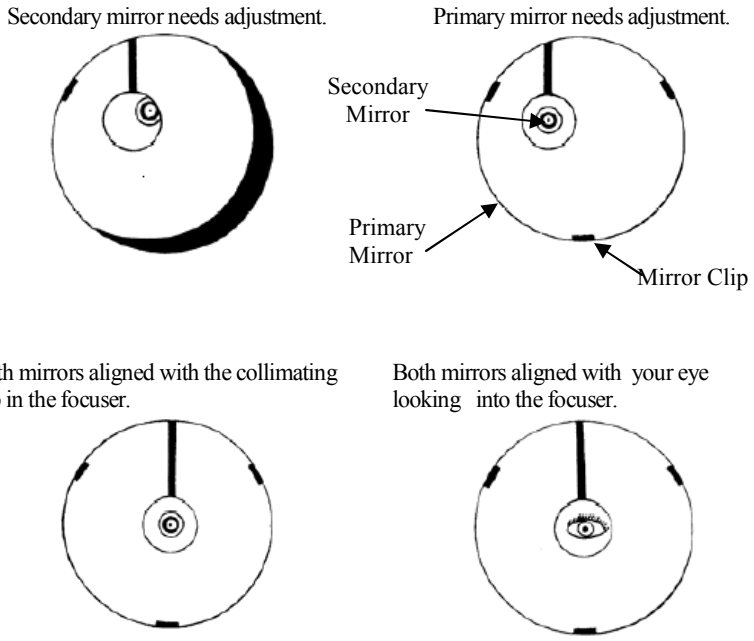

Secondary mirror needs adjustment.
Primary mirror needs adjustment.
Secondary Mirror
Primary Mirror
Mirror Clip
Both mirrors aligned with the collimating cap in the focuser.
Both mirrors aligned with your eye looking into the focuser.

Figure 7-1 PowerSeeker 114EQ

Night Time Star Collimating

After successfully completing daytime collimation, night time star collimation can be done by closely adjusting the primary mirror while the telescope tube is on its mount and pointing at a bright star. The telescope should be set up at night and a star's image should be studied at medium to high power (30-60 power per inch of aperture). If a non-symmetrical focus pattern is present, then it may be possible to correct this by re-collimating only the primary mirror.

Procedure (Please read this section completely before beginning):

To star collimate in the Northern Hemisphere, point at a stationary star like the North Star (Polaris). It can be found in the north sky, at a distance above the horizon equal to your latitude. It's also the end star in the handle of the Little Dipper. Polaris is not the brightest star in the sky and may even appear dim, depending upon your sky conditions. For the Southern Hemisphere, point at Sigma Octantis.

Prior to re-collimating the primary mirror, locate the collimation screws on the rear of the telescope tube. The rear cell (shown in Figure 7-1) has three large thumbscrews (on some models they are not thumbscrews) which are used for collimation and three small thumbscrews which are used to lock the mirror in place. The collimation screws tilt the primary mirror. You will start by loosening the small locking screws a few turns each. Normally, motions on the order of an $^{1}/_{8}$ turn will make a difference, with approximately a $^{1}/_{2}$ to $^{3}/_{4}$ turn being the maximum required for the large collimation screws. Turn one collimation screw at a time and with a collimation tool or eyepiece see how the collimation is affected (see the following paragraph below). It will take some experimenting but you will eventually get the centering you desire.

It is best to use the optional collimation tool or collimating eyepiece. Look into the focuser and notice if the secondary reflection has moved closer to the center of the primary mirror.

With Polaris or a bright star centered within the field of view, focus with either the standard ocular or your highest power ocular, i.e. the shortest focal length in mm, such as a 6mm or 4mm. Another option is to use a longer focal length ocular with a Barlow lens. When a star is in focus it should look like a sharp pinpoint of light. If, when focusing on the star, it is irregular in shape or appears to have a flare of light at its edge, this means your mirrors aren't in alignment. If you notice the appearance of a flare of light from the star that remains stable in location, just as you go in and out of exact focus, then re-collimation will help sharpen the image.

When satisfied with the collimation, tighten the small locking screws

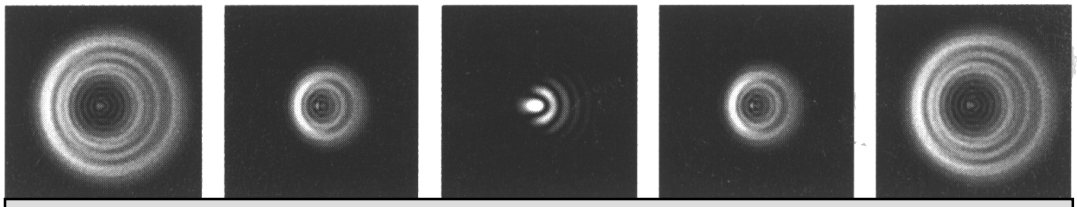


Figure 7-2
Even though the star pattern appears the same on both sides of focus, they are asymmetric. The dark obstruction is skewed off to the left side of the diffraction pattern indicating poor collimation.

Take note of the direction the light appears to flare. For example, if it appears to flare toward the three o'clock position in the field of view, then you must move whichever screw or combination of collimation screws necessary to move the star's image toward the direction of the flaring. In this example, you would want to move the image of the star in your eyepiece, by adjusting the collimation screws, toward the three o'clock position in the field of view. It may only be necessary to adjust a screw enough to move the star's image from the center of the field of view to about halfway, or less, toward the field's edge (when using a high power ocular).

Collimation adjustments are best made while viewing the star's position in the field of view and turning the adjustment screws simultaneously. This way, you can see exactly which way the movement occurs. It may be helpful to have two people working together: one viewing and instructing which screws to turn and by how much, and the other performing the adjustments.

IMPORTANT: After making the first, or each adjustment, it is necessary to re-aim the telescope tube to re-center the star again in the center of the field of view. The star image can then be judged for symmetry by going just inside and outside of exact focus and noting the star's pattern. Improvement should be seen if the proper adjustments are made. Since three screws are present, it may be necessary to move at least two to achieve the necessary mirror movement.

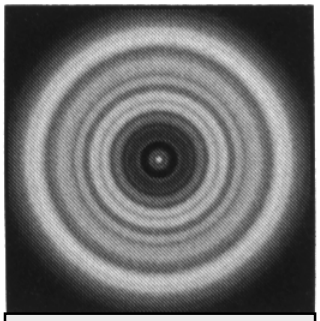
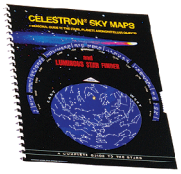


Figure 7-3
A collimated telescope should appear as a symmetrical ring pattern similar to the diffraction disk seen here.

CELESTRON Optional Accessories

You will find that additional accessories for your PowerSeeker telescope will enhance your viewing pleasure and expand the usefulness of your telescope. This is just a short listing of various accessories with a brief description. Visit the Celestron website or the Celestron Accessory Catalog for complete descriptions and all accessories available.



Sky Maps (# 93722) – Celestron Sky Maps are the ideal teaching guide for learning the night sky. Even if you already know your way around the major constellations, these maps can help you locate all kinds of fascinating objects.

Omni Plossl Eyepieces – These eyepieces are economically priced and offer razor sharp views across the entire field. They are a 4-element lens design and have the following focal lengths: 4mm, 6mm, 9mm, 12.5mm, 15mm, 20mm, 25mm, 32mm, and 40mm – all in 1.25" barrels.

Omni Barlow Lens (# 93326)– Used with any eyepiece, it doubles the magnification of that eyepiece. A Barlow lens is a negative lens that increases the focal length of a telescope. The 2x Omni is a 1.25" barrel, is under 3" (76mm) long, and weights only 4oz. (113gr.).

Moon Filter (# 94119-A) – This is an economical 1.25" eyepiece filter for reducing the brightness of the moon and improving contrast, so greater detail can be observed on the lunar surface.

UHC/LPR Filter 1.25" (# 94123) – This filter is designed to enhance your views of deep sky astronomical objects when viewed from urban areas. It selectively reduces the transmission of certain wavelengths of light, specifically those produced by artificial lights.

Flashlight, Night Vision (# 93588) – The Celestron flashlight uses two red LED's to preserve night vision better than red filters or other devices. Brightness is adjustable. Operates on a single 9-volt included battery.

Collimation Tool (# 94183) – Collimating your Newtonian telescope is easily accomplished with this handy accessory which includes detailed instructions.

Collimation Eyepiece – 1.25" (# 94182) – The collimation eyepiece is ideal for precise collimation of Newtonian telescopes.

Digital Camera Adapter – Universal (# 93626) – A universal mounting platform that allows you to do afocal photography (photography through the eyepiece of a telescope) using 1.25" eyepieces with your digital camera.

T-Adapter – Universal 1.25" (# 93625) – This adapter fits the 1.25" focuser of your telescope. It allows you to attach your 35mm SLR camera for terrestrial as well as lunar and planetary photography.

Motor Drive (# 93514) – A single axis (R.A.) motor drive for the PowerSeeker telescopes compensates for the earth's rotation keeping an object in the eyepiece field of view. This makes observing much more enjoyable and eliminates the constant use of the manual slow motion controls.

POWERSEEKER SPECIFICATIONS					
Model Number	**21043**	**21037**	**21048**	**21045**	**21049**
Description	**PS 60EQ**	**PS 70EQ**	**PS 80EQ**	**PS 114EQ**	**PS 127EQ**
Optical Design	Refractor	Refractor	Refractor	Newtonian	Newtonian
Aperture	60mm (2.4")	70mm (2.8")	80mm (3.1")	114mm (4.5")	127mm (5")
Focal Length	900mm	700mm	900mm	900mm	1000mm
Focal Ratio	f/15	f/10	f/11	f/8	f/8
Optical Coatings	Fully Coated	Fully Coated	Fully Coated	Fully Coated	Fully Coated
Finderscope	5x24	5x24	5x24	5x24	5x24
Diagonal 1.25"	Erect Image	Erect Image	Erect Image	n/a	n/a
Eyepieces 1.25"	20mm (45x)	20mm (35x)	20mm (45x)	20mm Erect	20mm Erect
				Image (45x)	Image (50x)
	4mm (225x)	4mm (175x)	4mm (225x)	4mm (225x)	4mm (250x)
Barlow Lens 1.25" 3x	yes	yes	yes	yes	yes
Angular Field of View w/20mm eyepiece	1.1°	1.4°	1.1°	1.1°	1.0°
Linear FOV w/20mm eyepiece -ft/1000yds	58	74	58	58	53
Mount	Equatorial	Equatorial	Equatorial	Equatorial	Equatorial
RA & DEC Setting Circles	yes	yes	yes	yes	yes
RA & DEC Slow-Motion Cables	yes	yes	yes	yes	yes
CD-ROM "The Sky" Level 1	yes	yes	yes	yes	yes
Highest Useful Magnification	142x	165x	189x	269x	300x
Limiting Stellar Magnitude	11.4	11.7	12.0	12.8	13.0
Resolution -- Raleigh (arc seconds)	2.31	1.98	1.73	1.21	1.09
Resolution -- Dawes Limit " "	1.93	1.66	1.45	1.02	0.91
Light Gathering Power	73x	100x	131x	265x	329x
Counterweight(s) – approximate weight (rounded)	2 lbs. (0.9kg)	4 lbs. (1.8kg)	4 lbs. (1.8kg)	6 lbs. (2.7kg)	1at 6 lbs. (2.7kg) & 1at 2lbs. (0.9kg)
Optical Tube Length	38" (97cm)	30" (76cm)	37" (94cm)	35" (89cm)	18" (46cm)
Telescope Weight	14 lbs. (6.4kg)	14 lbs. (6.4kg)	18 lbs. (8.2kg)	19 lbs. (8.6kg)	22 lbs. (10.0kg)
Note: Specifications are subject to change without notice or obligation					

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